# ORCA Network & Network Security

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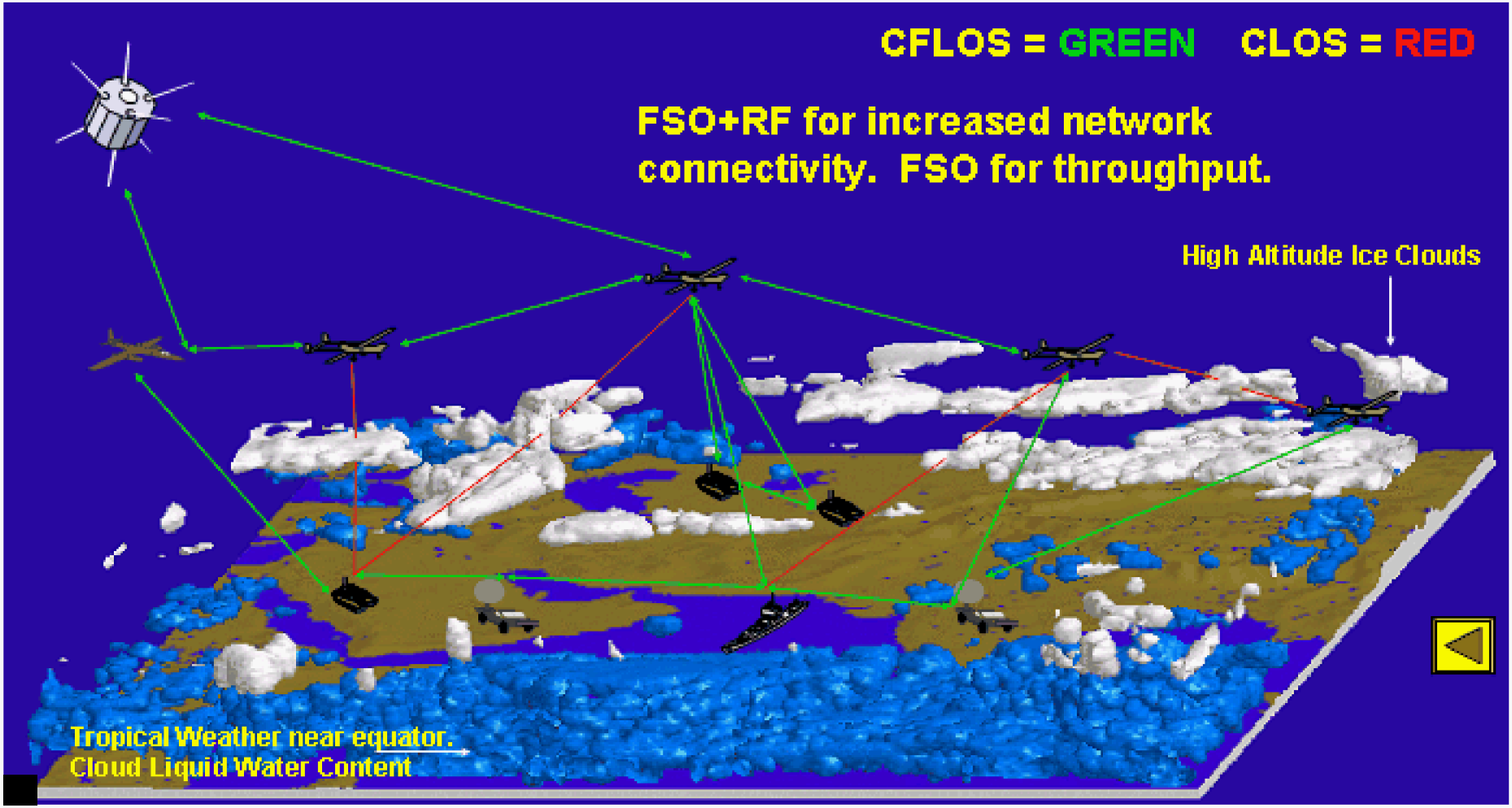
ORCA Proposers' Day
11 July 2007

# Hybrid Free Space Optical / RF Communications

Note: Any government collaboration information take precedence over the information contained in this presentation.




**"Clouds Get In the Way" -- Reduces FSO Link Availability …**
**… RF Addition Improves System Availability**

# ORCA CONOPS

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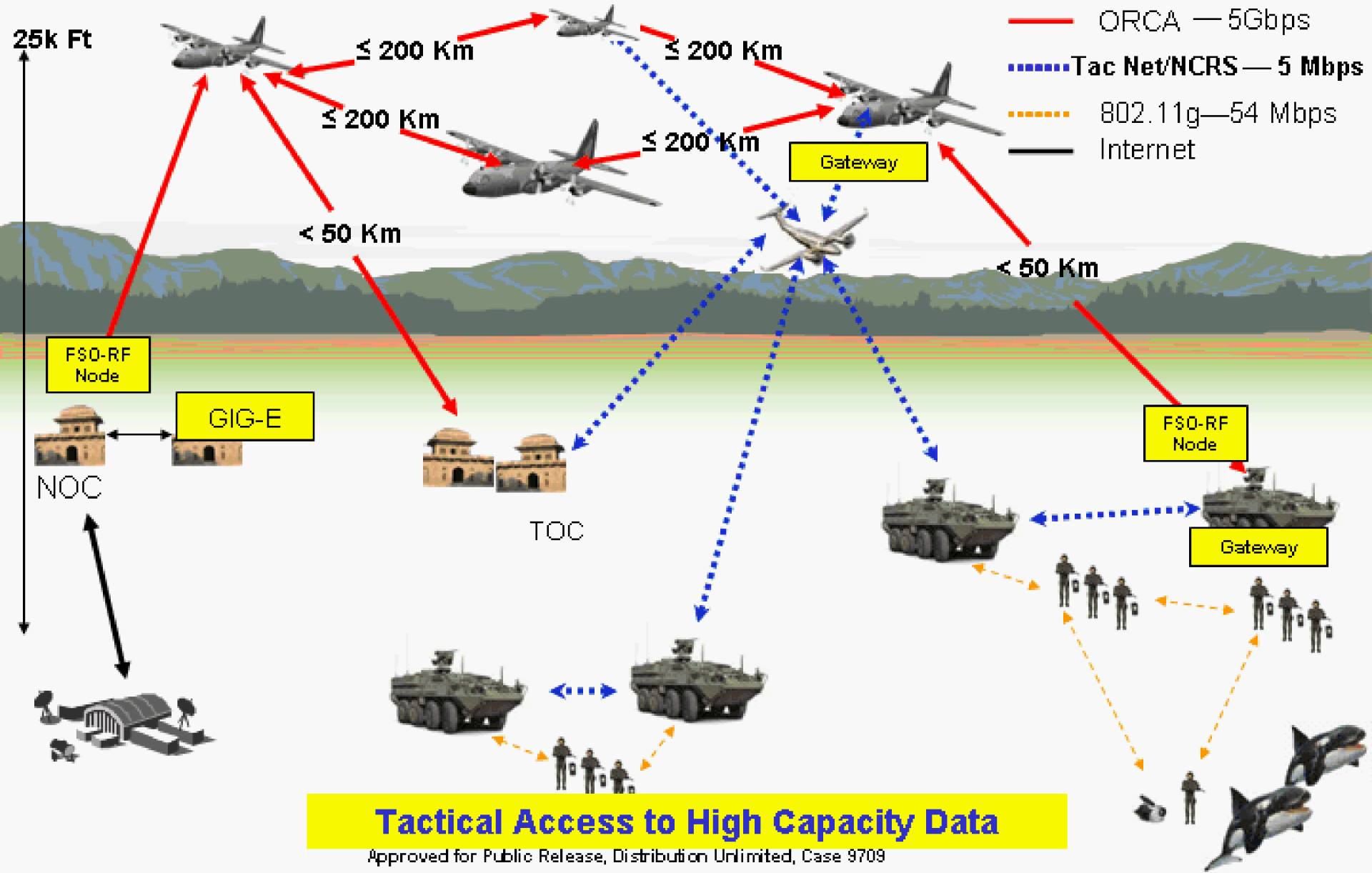


**Tactical Access to High Capacity Data**

# ORCA Demonstration and Metrics

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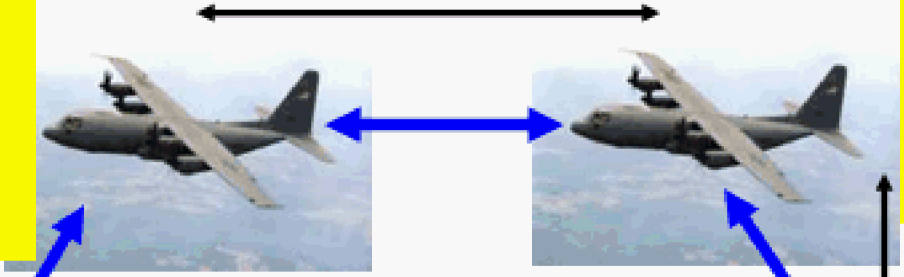
## Ground Platform Environment

- 0-65MPH On the Halt/On the Move
- Maximum Slant Range to C130: 50 Km
- Vibration spectrum: HUMMV Power Spectrum Density
- 2π Hemispheric Coverage
- Laser: Eye safe to operators

100-200 km



## Airborne Platform Environment

- 325 kts at 25 kft altitude,
- Maximum Slant Range to HUM: 50 Km
- Maximum Slant Range to another C130: 200 Km
- 4π Hemispheric Coverage
- Laser: Eye safe to operators

## Air-air crosslink

- Full duplex
- System availability—90%
- FSO--5Gbps@90% availability
- RF—274 Mbps@95%
- Support air-air and air-ground simultaneously

10 K - 30 K ft

30-50 km Slant Range

Interface with Local Ground network

## Air-ground link

- Full duplex
- System availability—90%
- FSO—2.5Gbps@60% availability
- RF—274 Mbps@95% availability
- Interface with GIG-E and NCRS

# ORCA Technical Challenges

Note: Any government collaboration information take precedence over the information contained in this presentation.

- Physical Links
  - > 5 Gb/s FSO Link: Power*Aperture product conducive to Link Margin and SWaP
    - FSO Data Rate > 2.5 Gb/s, Air-to-Ground / Ground-to-Air
    - FSO Data Rate > 5 Gb/s, Air-to-Air
  - 274 Mb/s RF Link: Power*Aperture product conducive to Link Margin and SWaP
    - Spectrum efficiency in available bands enabling Gb/s at military ranges >200Km
  - Nominal 40-50 dB variation because of atmospheric turbulence (i.e., scintillation)
  - Link Availability because of limited Power*Aperture product
  - Aero-Optic effects in airborne platforms
  - Affordable Pointing, Acquisition, Tracking
  - Obscurants (clouds, haze, rain, snow)
  - Receiver Performance vs Complexity (e.g., APD, PIN, PMT)
- **Network**
  - **Network traffic:**
    - **Characteristics of data sources. (Volume, Burst, Stream)**
  - **Traffic demand. (Consumers, Diversity)**
    - **Network element capability:**
    - **Mobility, altitude, orbital pattern.**
    - **Link or port density.**
  - **Survivability**
    - **Tolerance of network to node or link outage.**
  - **Reliability with limited redundancy, intermittent, directional links**
  - **5+ Gb/s encryption of a highly mobile transitory node network**
  - **Dynamic QOS to provide 'Dial Tone' i.e. >95% network availability**
    - **Traffic prioritization, dynamic link allocation, buffering routers**
- Platform
  - Air Segment
    - Minimizing SWaP and Mold Line impacts to vehicle (drag & weight = fuel)
  - Ground Segment
    - Mobile ground optical terminal

**Red = key challenges**

# Hybrid System Considerations

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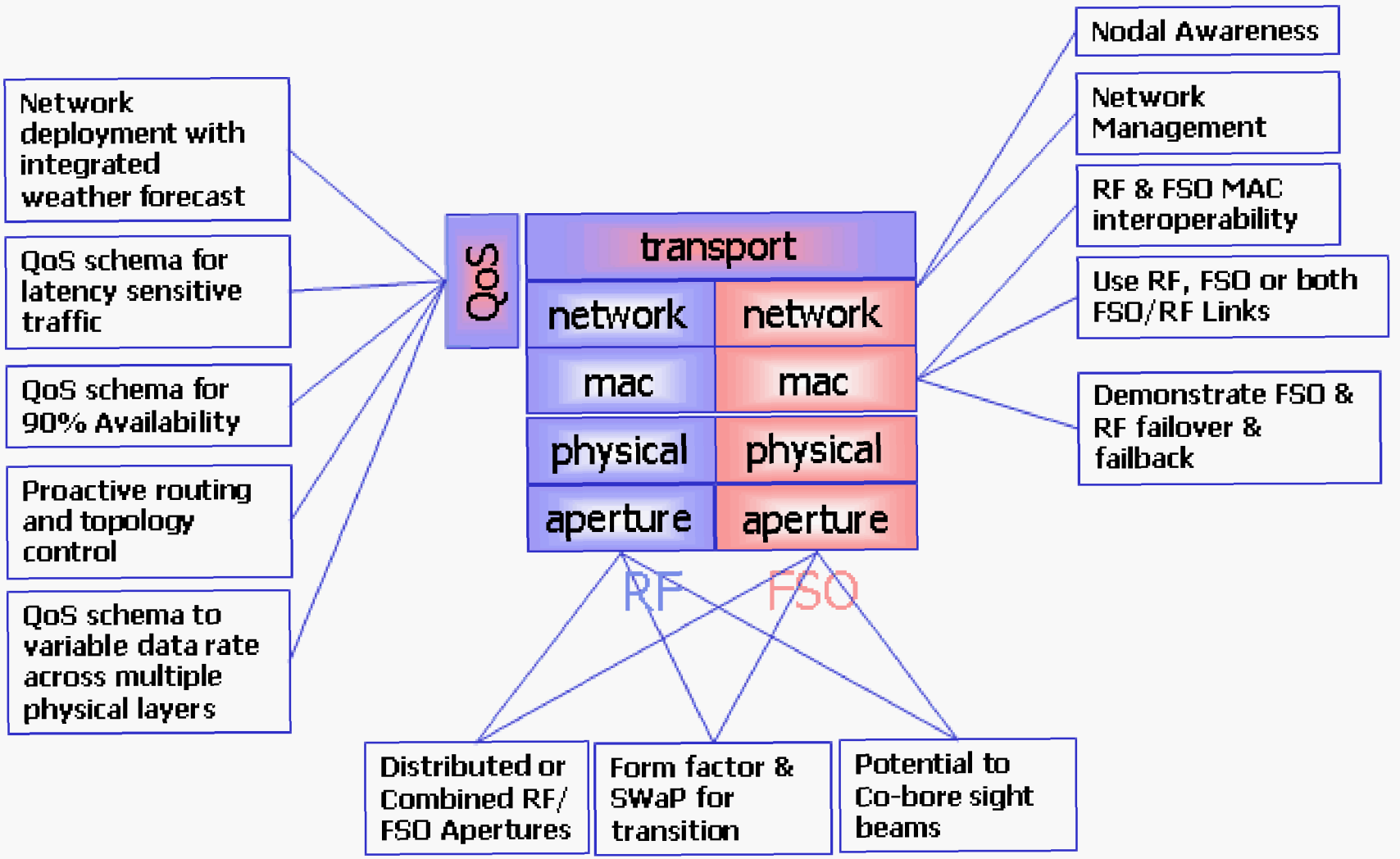

# ORCA Strawman Network

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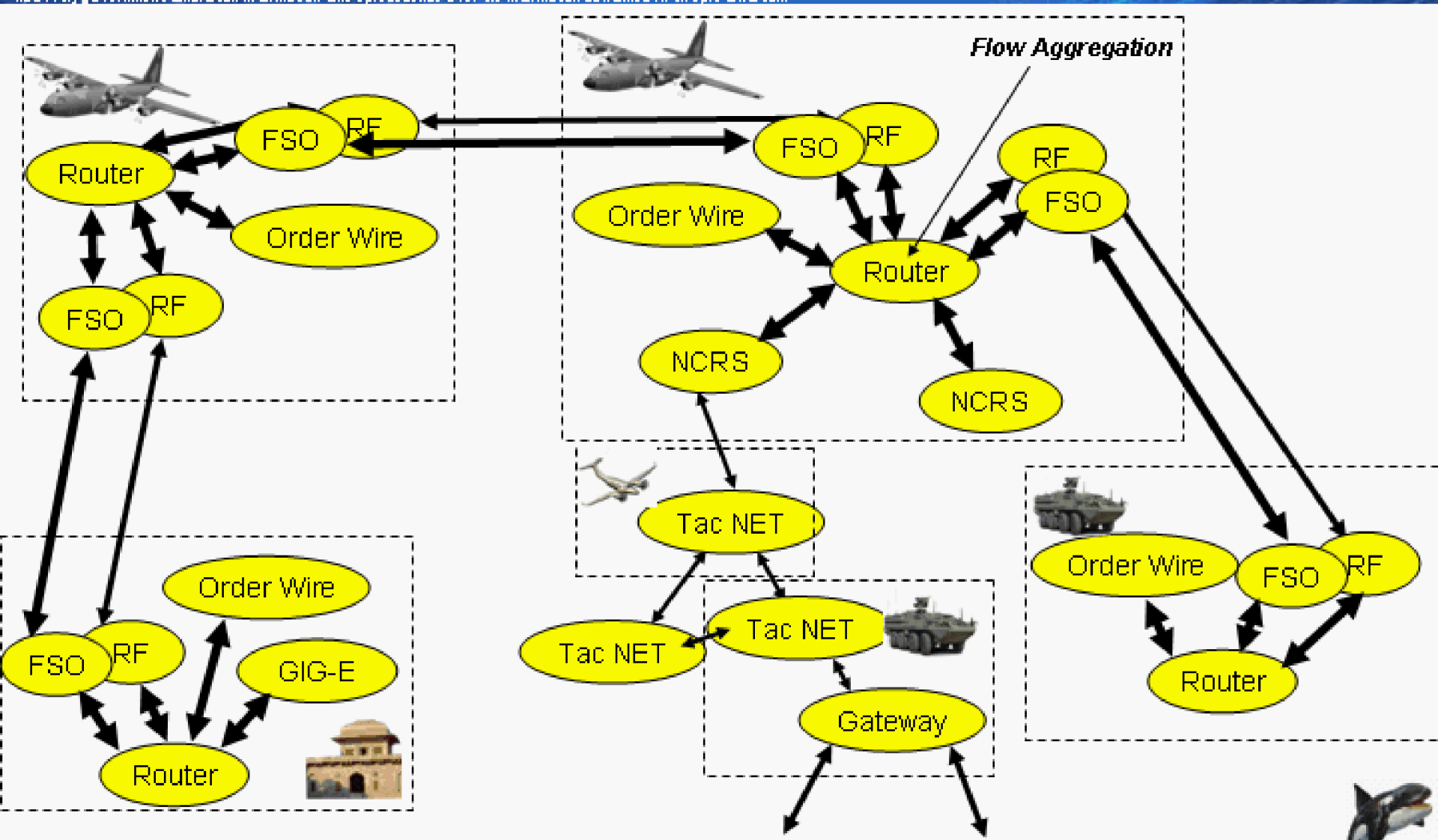

# ORCA Networking

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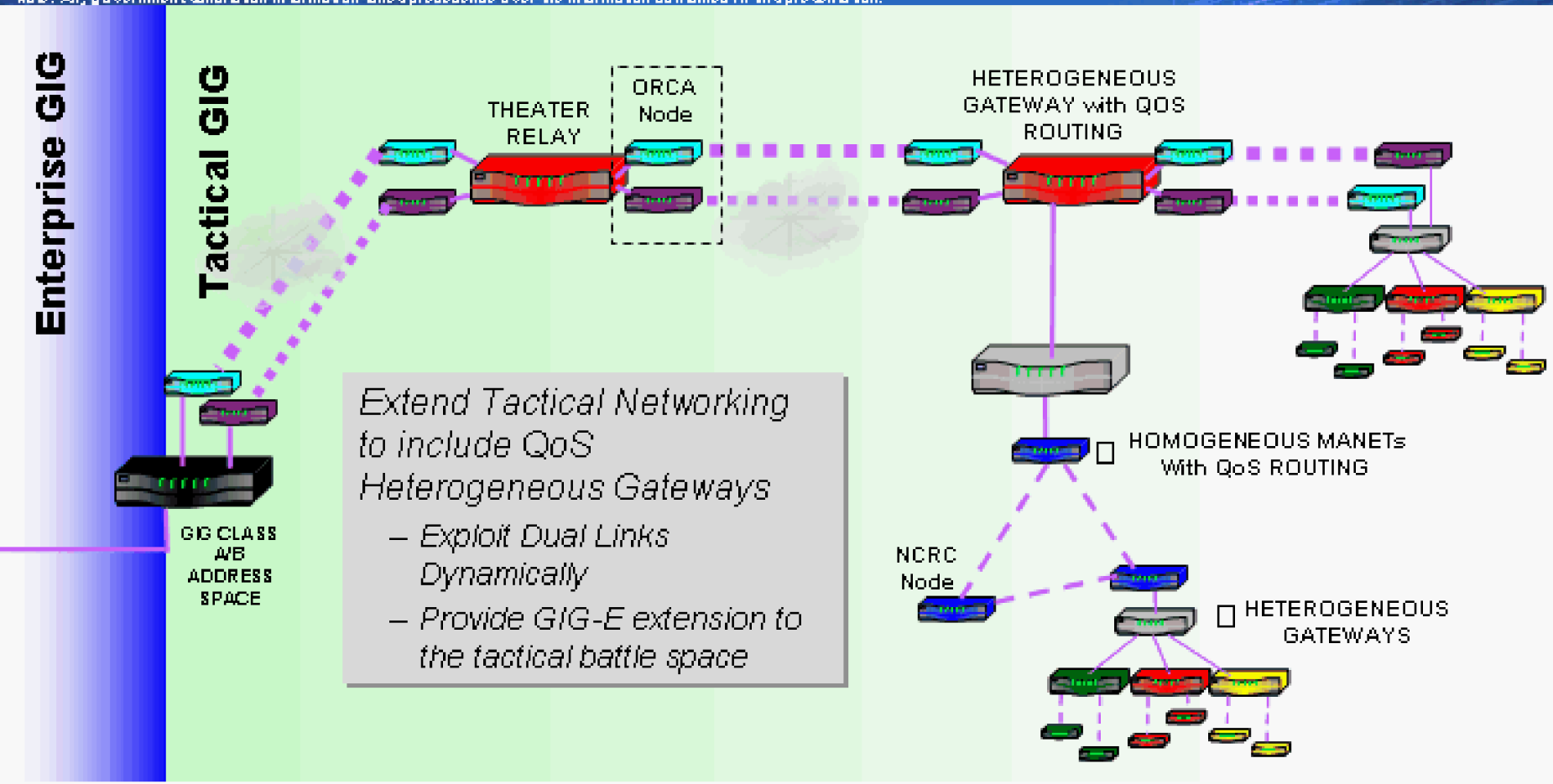


Networking Challenges:

- Extending Tactical Network: Provide QoS at gigabit rates across heterogeneous nodes with data aggregation
- Dynamics: Soft handoffs between dual links due to connectivity degradations
- Security: Provide gigabit rate IPSEC/HAIPE for tactical nodes

# ORCA Extended Network

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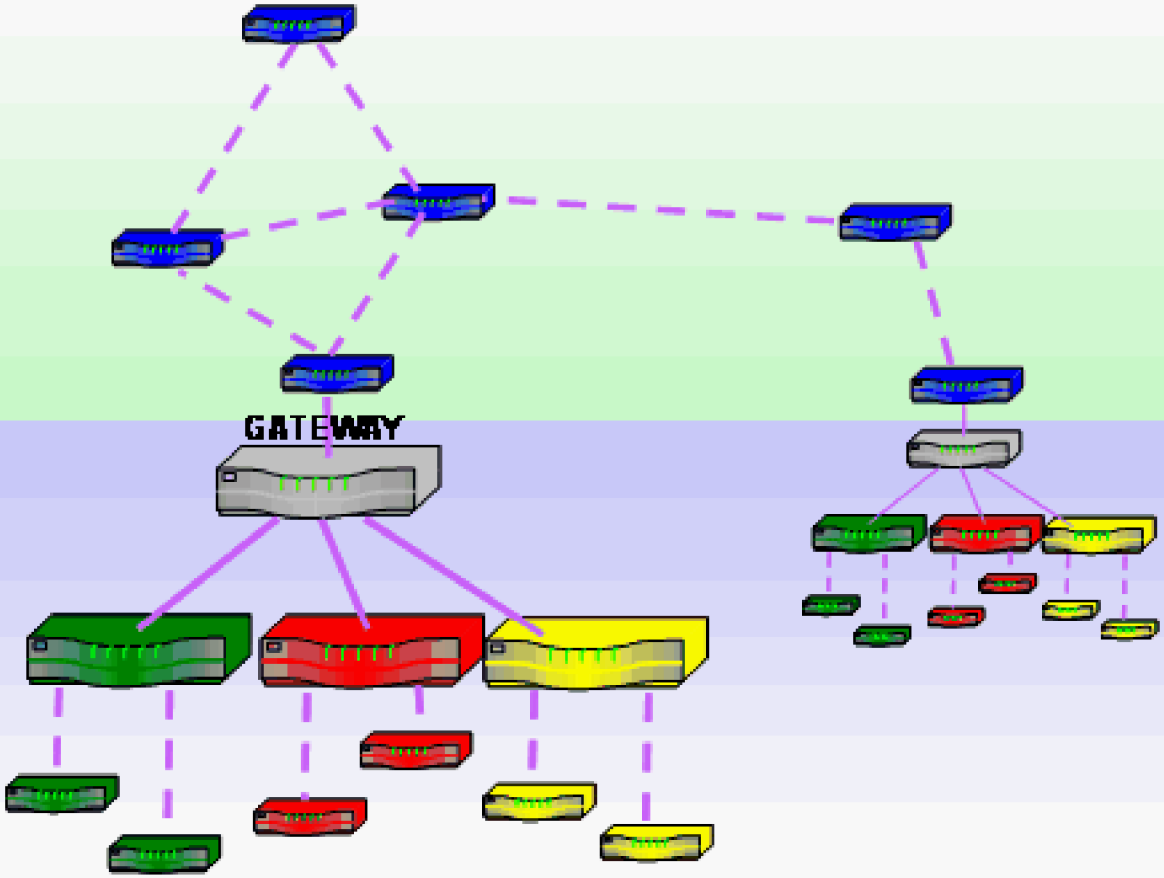
## Tactical Backbone Network




- Successful *homogeneous* MANETs using advanced Scheduling, QoS, and Routing Technology
- Successful *heterogeneous* Gateways using IP-based applications as "Stub-nets" to MANET backbone

# DTN in CONDOR Context

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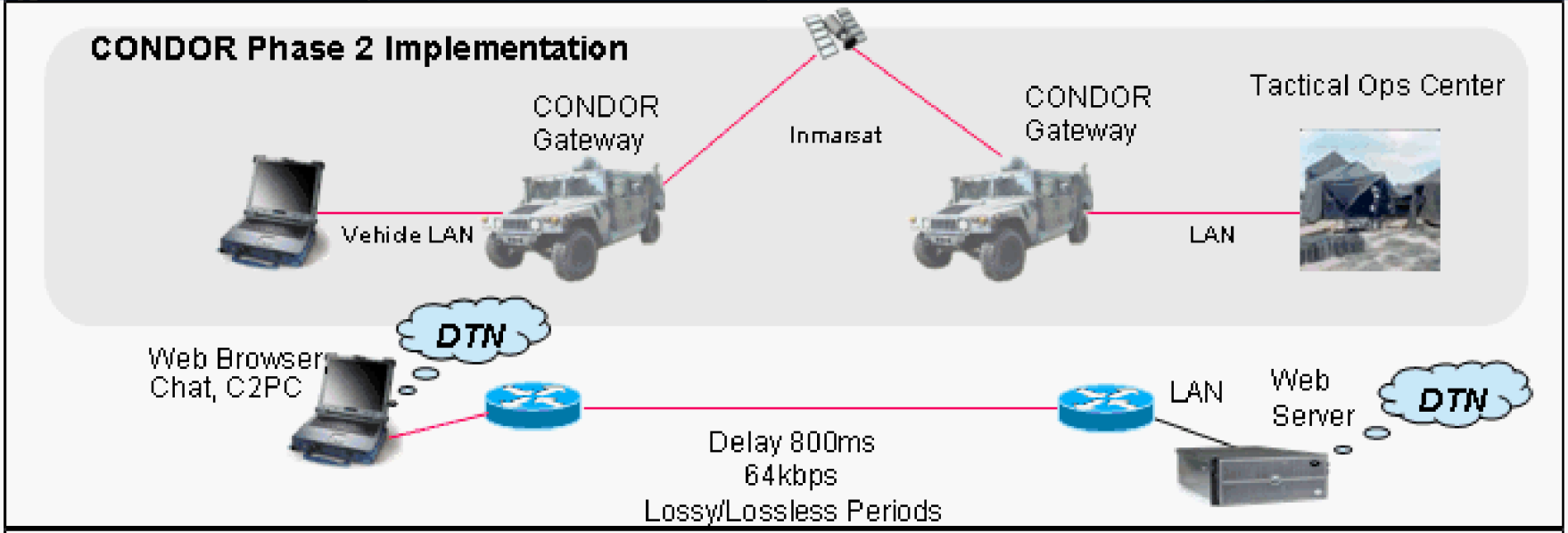


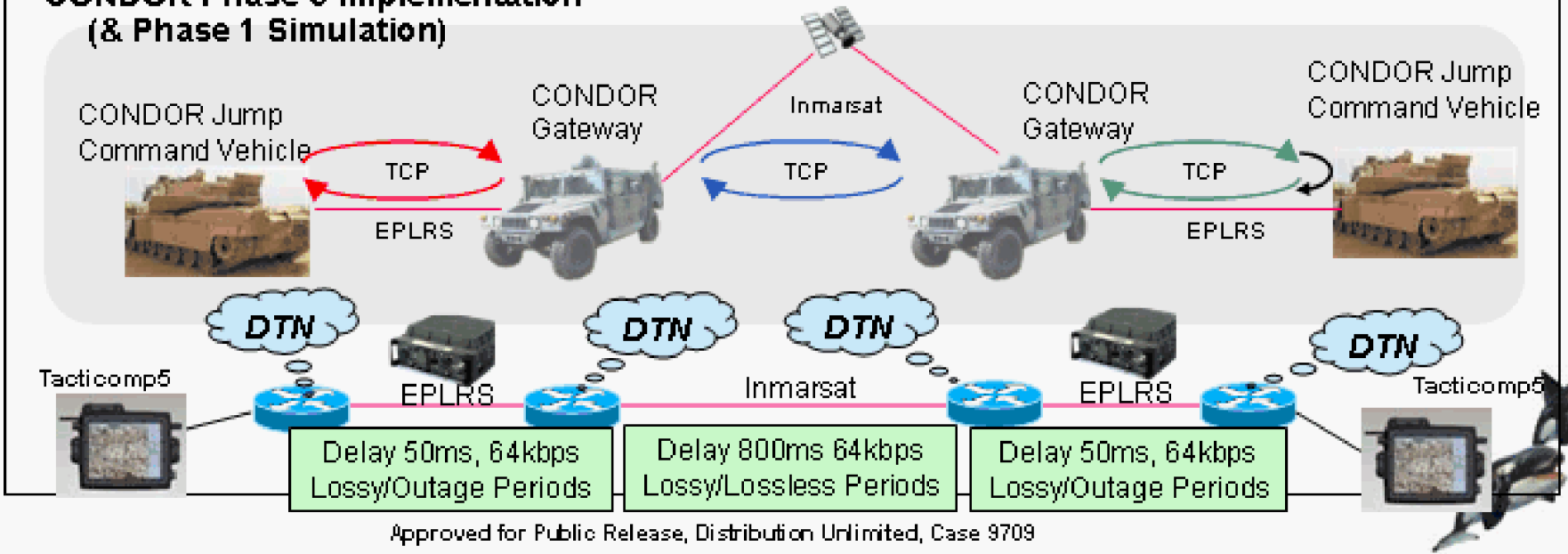

# Disruption Tolerance

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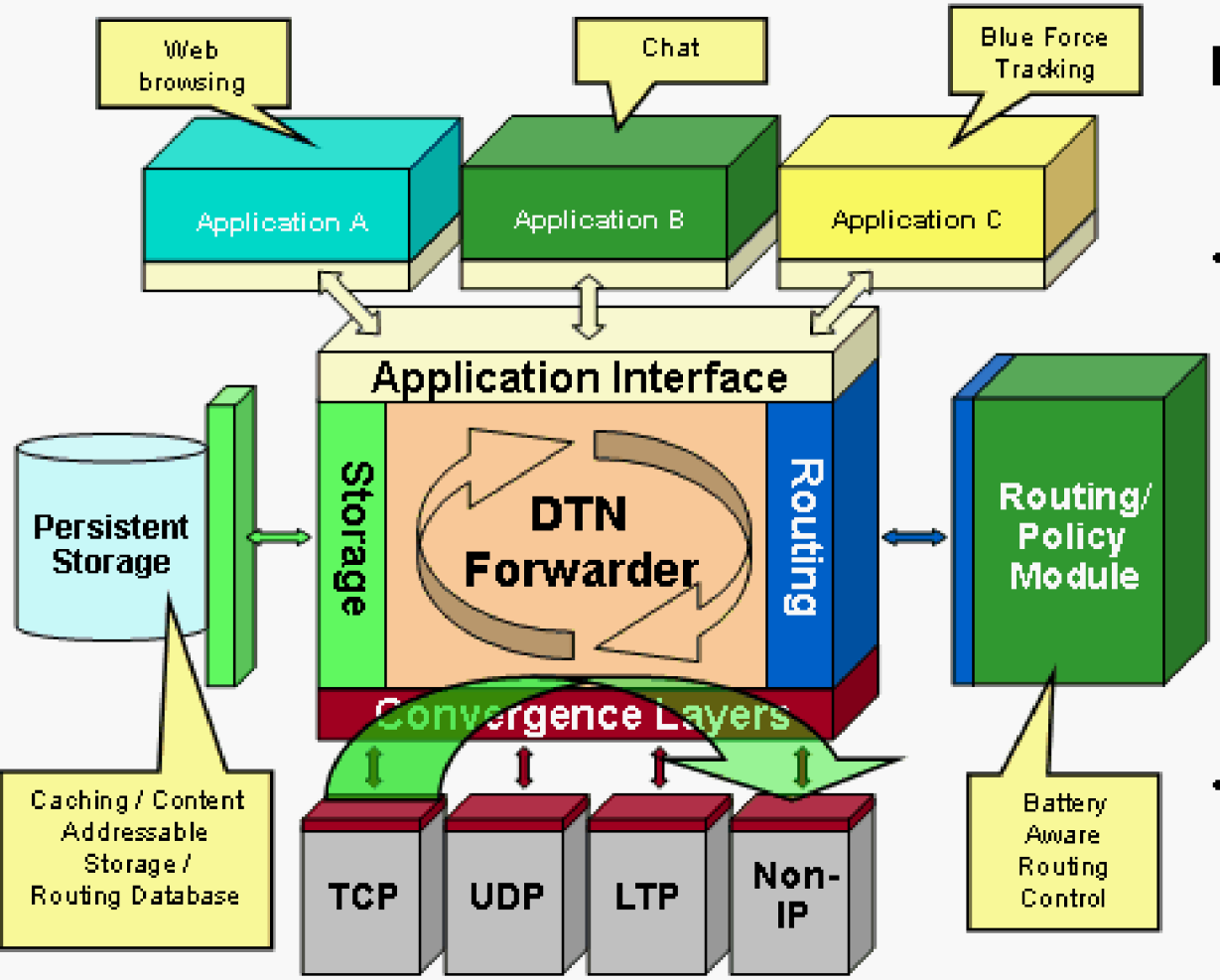


**Modularization thru RPC-like/XML interfaces – toolchain independent**

- **Isolates core forwarding functionality by specifying plug-in extension interfaces.**
  - Benefit from COTS economies of scale
  - Allow DoD-specific extensions
  - No need to stovepipe
  - Plug-ins allow cost control
  - Export control simplified
- **No Military Code / Requirements in Open Source Product**

Bridge between heterogeneous networks

**COTS economies of scale *without* the COTS functionality straitjacket!**

# Phase 1 Metrics (cont)

Note: Any government solicitation information take precedence over the information contained in this presentation.

| 7. NETWORKING | *System networking architecture includes:* | Italic Items are primary Metric; Un-italic items are Sub-metrics to primary Metric |
|---|---|---|
| | Ground node that with a direct interface to the GIG, ground node with a direct interface to tactical network gateway, airborne networking segment that provides connectivity between ground GIG node and tactical network gateway node; | |
| | Conformity to IPv6 protocol standard IPv6 inclusive of link/network security | |
| | Inclusion of link disruption mitigation protocols | |
| | Support to all DoD QoS services defined by ASD NII | |
| | Airborne networking segment that supports ≥ 4 platforms with multiple networking nodes; | |
| | End-to-end network configuration with minimum support to: one ground GIG node, four airborne platforms each with multiple nodes for mesh and/or mobile ad hoc networking support, and two ground tactical network nodes each with up to 64 IP addressable tactical communications nodes | |
| | Secure communications capability (i.e. HAIPE) for end-to-end secure transport that is permissible by the source and destination pair | |
| | Traffic shaping/prioritization to allow resource management between high priority, low latency internal ORCA network traffic and lower priority, latency tolerant external ORCA network traffic. | |
| | *Successful Laboratory demonstration of the core technologies used in the system networking architecture* | |

# Phase 2 Metrics (cont)

Note: Any government solicitation information take precedence over the information contained in this presentation.

| | | |
|---|---|---|
| 9. NETWORKING | *protocol standard IPv6 inclusive of link/network security* | Italic Items are primary Metric; Un-italic items are Sub-metrics to primary Metric |
| | *Demonstration of Network Connectivity to GIG and tactical gateway (defined by govt)* | |
| | *Field demonstration of airborne segment networking supporting two air platforms and two mountains, with multiple networking* | |
| | Maintain end-to-end connectivity of airborne segment of >99% reliability with 75% of end-to-end disruptions <5 sec | |
| | Secure communications capability (i.e. HAIPE) for end-to-end secure transport that is permissible by the source and destination pair; | |
| | *Laboratory demonstration end-to-end network performance utilizing four airborne nodes and two ground nodes* | |
| | Demo of link disruption mitigation protocols to link disruptions of >5 sec without connection loss | |
| | Network simulations of multiple nodes to reach 90% system availability of 250 Mbps data rate | |
| | Support of up to two stub networks, each with 64 IP-addressable nodes; | |
| | *Laboratory demonstration of traffic shaping/prioritization to allow resource management between high priority, low latency internal ORCA network traffic and lower priority, latency tolerant external ORCA network traffic.* | |

# Phase 3 Metrics (cont)

Note: Any government calibration information take precedence over the information contained in this presentation.

| | | |
|---|---|---|
| 4. RF AIR/GND Uplink/Downlink | | |
| Overall Data Rate | 274 Mb/s | AIR Altitude ~ 25 kft & 10 kft MSL |
| Overall Information Rate | >185 Mb/s | GND Altitude ~ 0 MSL nominal; Rate 3/4 coding + 10% protocol overhead |
| RF Link Availability | ≥ 95% | Range ≤ 50 km |
| Bit Error Rate | ≤ 4 E-05 (uncorrected) | Node-to-node |
| | ≤ 4 E-07 (corrected) | Various Times of Day & Night |
| | | Availability tests over 2 hours period |
| | | Full-Duplex |
| | | Transceiver Coverage = 4π |
| | | GND Transceiver Coverage = 2π |
| | | GND Transceiver Speed = 0-65 mph |
| | | Aircraft Speed = 200-250 kts IAS |
| | | |
| 5. NETWORKING | *Field demonstration of airborne segment networking supporting three platforms, a ground node with direct interface to the GIG, and two ground nodes with an interface to a tactical gateway supporting up to 64 IP-addressable nodes* | Italic Items are primary Metric; Un-italic items are Sub-metrics to primary Metric |
| | Demonstrate end-to-end connectivity (between GIG and tactical gateway) of >95% reliability with 75% of end-to-end disruptions <5 sec; | |
| | Secure communications capability (i.e. HAIPE) for end-to-end secure transport that is permissible by the source and destination pair; | |
| | Demonstrate the implementation of a packet prioritization mechanism between external ORCA and internal ORCA network traffic | |
| | Demonstrate multiple service capabilities:<br>Voice<br>Interactive data<br>Video<br>Bulk data transfer<br>Real-time video | |

# ORCA Networking Summary

Note: Any government collaboration information take precedence over the information contained in this presentation.

- ORCA network can be considered a stub-network off of existing GIG infrastructure;
- Networking needs to address the characteristics of the individual links (geometry and physical layer) to produce a reliable END-to-END capability;
- Networking must be compatible with existing network architectures inclusive of security and QoS requirements